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MULTI-BAND FREQUENCY SYNTHESIZER

The present invention relates to a multi-band frequency synthesizer controlled by a phase locked loop including a voltage-controlled oscillator (VCO).

The known multi-band frequency synthesizers or generators include control loops, each controlling one of the possible frequency bands by means of a variable frequency, voltage-controlled, oscillator, the selection between the frequency signals output from these oscillators being performed by a commutator connected to the output of these oscillators. In each of loops a phase comparator receives signals respectively representative of a frequency of reference as well as the frequency output from the concerning oscillator in order to perform the frequency control.

However, the characteristics and in particular the gain, of the various elements constituting the loop may vary in function of the frequency of the loop, this separates their function from an optimal function for which they are provided. And, in particular, since the frequency of reference is output from a fixed frequency generator, it is necessary to have a frequency changer commandable on one of the inputs of the comparator, in order to be able to select the frequency of the loop. To have more flexibility in the selection of the loop frequency, a changer of frequency may be even provided in the

form of, for example a frequency divider dedicated to each input of the comparator, this allows to compare the submultiples of the different range of the frequency of the fixed frequency generator with that of the loop frequency. However, the presence of a frequency changer on the input of the comparator receiving the signal incoming from the variable frequency oscillator causes the latter to perceive as having a variable sensitivity in Hertz/Volt with the loop frequency, so that the global gain of the loop may depend on the loop frequency and may block an optimal functioning on all of the extent of the possible frequencies.

From this fact, the multi-band frequency generators comprise as many control loops as the bands, with the inconvenience introduced by an increase of cost. The present invention has been devised to alleviate this inconvenience.

As a result, the multi-band frequency synthesizer in accordance with the present invention, which includes an voltage-controlled oscillator of frequency, configured to be controlled of frequency by the control loop receiving a frequency regulating signal, and including a comparator, is characterized in that it comprises at least another voltage-controlled oscillator of frequency, said control loop being configured to control the frequency of said another oscillator as well, and that the comparator is variable gained.

One may use only one loop for performing the control in

accordance with the desired frequency in function of the regulating signal, the two oscillators being commanded in an optimal manner regardless of the frequency.

Advantageously, said control loop comprises a phase comparator of programmable gain.

One can thus adopt this comparator in function of the desired frequency so that it supplies an error signal having a sensitivity in relation to the phase, which is adopted in function of the frequency of the loop, this is for compensating for the variations of gain of the loop in function of the frequency, due to other elements, which could no more allow an optimal function. Said control loop comprises of preference a filter destined to improve the stability of the control. In order to permit to select more easily the frequencies, said control loop may comprise a frequency changer. One can also for example multiply or divide a frequency of reference and compare it to the frequency of the control loop, which is itself eventually multiplied or divided. If the loop include for example a frequency divider, which causes the fact that the comparator perceives a weaker frequency than that fed from the VCO, its sensitivity in comparison with the frequency of VCO, therefore the gain of the loop, will decrease enough, this can be compensated for by commanding an augmentation of the gain of this comparator. Said frequency changer may, in particular, be realized in a very simple manner, in the form of logic

counter.

The present invention will be better understood in conjunction with the following description of the best form of the preferred embodiment with reference to the unique drawing representative of the synthesizer in accordance with the present invention.

The frequency synthesizer in accordance with the present invention includes a first oscillator 2, of the type voltage-controlled oscillator, usually called VCO (stands for "voltage-controlled oscillator"), which is represented on the unique drawing. It includes an input 2c of voltage control by the frequency, and provides on the output 2f a first frequency F1. A second oscillator 3, of the same type as the oscillator 2, has its input 3c connected to the input 2C, while its output 3F provides a second frequency F2. The outputs 2F and 3F are connected, respectively, to a first input of signal 4A to a second input of signal 4B of a commutator 4 with two lines, including an input of command 4C, the state of which meets in relation to the first input of signal 4A or the second input of signal 4B, with an output 4S of this commutator 4. This commutator 4 has a similar arrangement for each line, which comprises, in series to the corresponding signal input, a resistor shown as R1 and R2 respectively, followed by a capacitor, shown as C1 and C2 respectively, and followed by a PIN-diode, P1 and P2 respectively, the cathodes of these diodes

P1 and P2 being connected together with the output 4S. The anodes of the PIN-diodes are also connected respectively to a resistor, respectively R3 and R4, the other terminal of which is connected respectively to a first output 5A and to a second output 5B of a relay 5 switching to two possible positions, to meet in relation an input of signal 5E with one or the other of said first or second output 5A and 5B, in function of a control signal applied to a command input 5C, connected to the command input 4C connected to one node of the coil, which is power-supplied, on the other node by a direct current not shown. The signal input 5E is connected to a resistor R5, connected to a positive power supply VP on the other node. On the other hand, the output 4S is connected to a resistor, R6 connected the ground on the other node.

The output 4S of the commutator is connected to the input of a frequency synthesizer 6, such as an integrated circuit manufactured by PHILIPS under the reference number UMA 1014T, including a comparator 7 receiving at a first input 7A the signal fed from said output 4S after having passed through a frequency divider 8, of which the dividing range R is directed by a frequency regulating signal SC, in the form of a number arriving from a regulation input 8C, while on the other hand a second input 7B of this comparator 7 receives the signal of frequency fed from a frequency generator 9. This frequency generator 9 supplies a logic signal in the form of repeating

intervals at the state high then low successively, representative of each half-period of the frequency in question, while the divider of frequency 8 supplies a signal of the same type transposing the alternance positive and negative of the signal fed from the oscillator 2 or 3. The comparator 7 is also to determine the phase distance between the signals applied to its two inputs 7A and 7B by measuring the period during which there is discordance between the state of its inputs, and by providing as output an error signal proportional to this time of discordance. The regulating signal SC is also applied to an input 10E of a decoder 10, of which the output 10S is connected to the command input 4C and to a gain-control input 7G of the comparator 7, and provides a binary signal indicative of the frequency F1 or F2 selected in function of the regulating signal SC.

The output of the comparator 7 is connected to the input of a filter 11, which eliminates the elevated frequencies and has a response curve of amplitude/frequency that satisfies the well-known criteria of stability, such as the criterion of Nyquist, the output of this filter being connected to the inputs 2C and 3C of the oscillators 2 and 3 of voltage-controlled frequency.

The function of this synthesizer is as follows. The regulating signal SC is applied to the input 8C of the frequency divider 8, resulting in that the input 7A of the comparator 7

receives the loop frequency issued from the output 4S divided by the dividing range R. On the other hand, this regulating signal SC commands also the state of the relay 5, through the decoder 10. In this manner, the anode of one of the PIN-diodes P1 or P2 receives a positive voltage, supplied from the power supply VP through the dividing bridge constituted of the resistors R5, R3 (or R4) and R6, while the other PIN-diode P2 or P1 has its anode "in the air", though its cathode is polarized positive by the voltage applied to the terminal of resistor R6, this blocks the latter diode P2 or P1. The dividing bridge is such that it allows the transit of the frequency wave having the amplitude of desired voltage, without the risk of being blocked. The loop signal of desired frequency issued from the oscillator 2 or 3 connected to the line including the conductive PIN-diode, P1 or P2, may be thus arrived through the frequency divider 8 to the input 7A of the comparator 7, which compares its frequency with that supplied from the frequency generator 9 to supplies a phase-error signal.

Since the sensitivity, expressed as Hertz/Volt, of the entity constituted by the phase controlled frequency oscillator 2 or 3 used and by the frequency divider 8, depends on the dividing range R of the latter, the gain of the comparator 7 is commanded by the signal issued from the output 10S of the decoder, in such a manner that it takes a compensative value, with respect to an optimal value, said variation of sensitivity

in Hertz/Volt due to the value particular of the dividing range R. One may then have a comparator 7 of programmable gain, which in this example has two possible gains, in relation equal to that of the frequencies F1 and F2. The error signal passes through the filter 11 to arrive to the input 2C and 3C of the oscillators 2 and 3 at a voltage-controllable frequency by having a dynamism of voltage of command, which is independent of the frequency of control loop, this allows using these two oscillators 2 and 3 approximately in a same manner.